

CLAIMS

What is claimed is:

- 1 1. A method comprising:
2 separately routing a metal and one or more of a complexing agent, a
3 buffer, a pH adjuster and a reducing agent for mixing and application to a wafer;
4 in-line heating the metal and the one or more of a complexing agent, a
5 buffer, a pH adjuster and a reducing agent to an application temperature, while
6 they are being routed; and
7 in-line mixing the heated metal and the heated one or more of a
8 complexing agent, a buffer, a pH adjuster and a reducing agent substantially just
9 prior to application to the wafer; and
10 applying the mixture of the heated metal and the heated one or more of a
11 complexing agent, a buffer, a pH adjuster and a reducing agent to the wafer.
- 1 2. The method of claim 1, wherein the metal is a selected one of Co, Cu, Ni,
2 Fe, Ag, Au, Pt, Pd and Ru.
- 1 3. The method of claim 1, wherein either a selected one of a citric acid and
2 EDTA is used as a complex agent, a selected one of NH₄Cl and a boric acid is
3 used as a buffer, a selected one of KOH and TMAH is used as a pH adjuster, or a
4 selected one of DMAB, hypophosphite, formaldehyde, and glyoxylic acid is used
5 as a reducing agent.

1 4. The method of claim 1, wherein said in-line heating comprises heating the
2 metal and the one or more of a complexing agent, a buffer, a pH adjuster and a
3 reducing agent to an application temperature in a range of 30 C – 90 C.

1 5. A system comprising:
2 a chamber to apply a plating solution to plate one or more wafers;
3 a plurality of tanks to separately hold a metal and one or more of a
4 complexing agent, a buffer, a pH adjuster and a reducing agent; and
5 a piping system having a plurality of segments, including a plurality of in-
6 line heaters for a subset of the segments, to separate route, in-line heat, and mix
7 to form the plating solution, substantially just prior to application, the metal and
8 the one or more of a complexing agent, a buffer, a pH adjuster and a reducing
9 agent, in-line heat the metal and the one or more of a complexing agent, a buffer,
10 a pH adjuster and a reducing agent.

1 6. The system of claim 5, wherein the plurality of tanks comprise a tank to
2 store a selected one of Co, Cu, Ni, Fe, Ag, Au, Pt, Pd and Ru.

1 7. The system of claim 5, wherein the plurality of tanks comprise a tank to
2 store either a selected one of a citric acid and EDTA to be used as a complex
3 agent, a selected one of NH₄Cl and a boric acid to be used as a buffer, a
4 selected one of KOH and TMAH to be used at a pH adjuster, or a selected one of
5 DMAB, hypophosphite, formaldehyde, and glyoxylic acid to be used as a
6 reducing agent.

1 8. The system of claim 5, wherein the in-line heaters are capable of in-line
2 heating the metal and the one or more of a complexing agent, a buffer, a pH
3 adjuster and a reducing agent to an application temperature in a range of 30 C –
4 90 C.

1 9. A method comprising:
2 heating DI water to a predetermined temperature;
3 pre-heating one or more pipeline segments, a chamber and a wafer to the
4 predetermined temperature employing the heated DI water;
5 in-line mixing a concentrated plating solution with the heated DI water in
6 said pre-heated one or more pipeline segments to form a diluted, but heated
7 plating solution, and routing the diluted, but heated plating solution to the
8 chamber; and
9 applying the diluted, but heated plating solution to the wafer.

1 10. The method of claim 9, wherein the DI water having a surfactant mixed in,
2 and the method further comprises mixing the DI water with the surfactant.

1 11. The method of claim 10, wherein the surfactant is a selected one of RE
2 610, Triton X100, polyethers, and polyoxyethylene.

1 12. The method of claim 1, wherein said heating of the DI water comprises
2 heating the DI water to a temperature in a temperature range of 70 C – 100 C.

1 13. The method of claim 9, wherein said in-line mixing comprises mixing 1 to
2 10 parts of the DI water with 1 part of the concentrated plating solution.

1 14. The method of claim 9, wherein said applying comprises applying 100
2 ml/min – 10l/min of the diluted, but heated plating solution to the wafer, rotating
3 with an angular speed greater than 10 revolutions per minute.

1 15. A system comprising:
2 a chamber to apply a plating solution to plate one or more wafers;
3 a heater to heat DI water to a predetermined temperature; and
4 a piping system having one or more pipe segments coupled to the heater
5 and the chamber, to allow at least a selected one of the one or more pipe
6 segments, the chamber and the wafer to be heated by the DI water, to in-line mix
7 a concentrated plating solution with the heated DI water to form said plating
8 solution, and to route said plating solution to said chamber.

1 16. The system of claim 15, wherein the DI water having a surfactant mixed
2 in, and the piping system further facilitates in-line mixing the DI water with the
3 surfactant.

1 17. The system of claim 16, wherein the surfactant is a selected one of RE
2 610, Triton X100, polyethers, and polyoxyethylene.

1 18. The system of claim 15, wherein the heater is equipped to heat the DI
2 water to a temperature in a temperature range of 70 C – 100 C.

1 19. The system of claim 15, wherein the piping system is designed to allow in-
2 line mixing of 1 to 10 parts of the DI water with 1 part of the concentrated plating
3 solution.

1 20. The system of claim 15, wherein the piping system is designed to allow a
2 flow of the plating solution at 100 ml to 10 l per minute to be applied to a wafer,
3 rotating with an angular speed greater than 10 revolutions per minute.

1 21. A method comprising:
2 forming a plating solution for plating a wafer;
3 configuring a piping system to route the plating solution for qualification
4 analysis;
5 performing said qualification analysis;
6 determining whether the plating solution passes the qualification analysis;
7 and
8 re-configuring the piping system to route the plating solution for application
9 on the wafer, if the plating solution passes the qualification analysis.

1 22. The method of claim 1, wherein said forming comprises mixing a metal
2 with one or more of a complexing agent, a buffer, a pH adjuster and a reducing
3 agent.

1 23. The method of claim 22, wherein said forming further comprises mixing DI
2 water with said mixture of a metal and at least a selected one of one or more of a
3 complexing agent, a buffer, a pH adjuster and a reducing agent.

1 24. The method of claim 22, wherein the method further comprises mixing DI
2 water and a surfactant, and said forming further comprises mixing said mixture of
3 DI water and surfactant with said mixture of a metal and at least a selected one

4 of one or more of a complexing agent, a buffer, a pH adjuster and a reducing
5 agent.

1 25. The method of claim 21, wherein said forming comprises heating the
2 plating solution to an application temperature.

1 26. The method of claim 21, wherein said forming comprises forming said
2 plating solution in a selected one of said piping system and a mixing tank.

1 27. The method of claim 21, wherein said configuring of a piping system
2 comprising configuring a valve of the piping system to route the plating solution
3 onto a first path for said qualification analysis, and said re-configuring of the
4 piping system comprising re-configuring the valve to route the plating solution
5 onto a second path for application.

1 28. The method of claim 21, wherein said performing of a qualification
2 analysis comprises performing one or more electroanalyses for one or more
3 reaction kinetics.

1 29. The method of claim 28, wherein said performing of one or more
2 electroanalyses for one or more reaction kinetics comprises performing one or
3 more electroanalyses for one or more of adsorption, nucleation, deposition rates,
4 pH balance, and particles generation, and comparing the result(s) against one or
5 more corresponding qualification metrics.

1 30. The method of 14, wherein said performing of one or more
2 electroanalyses for one or more reaction kinetics comprises performing one or
3 more of

4 a Quart Crystal Microbalance (QCM) analysis,
5 an Open Circuit potential (OCP) analysis,
6 a pH analysis,
7 a particle count analysis, and
8 a UV-VIS analysis
9

1 31. A system comprising:
2 an electroanalytical subsystem equipped to qualify a plating solution;
3 a chamber to apply a plating solution to plate one or more wafers; and
4 a piping system having a configurable value, a first route coupling the
5 valve and the electroanalytical subsystem, and a second route coupling the valve
6 and the chamber, allowing a plating solution to be routed to the electroanalytical
7 subsystem for qualification analysis, prior to being routed to the chamber for
8 application.

1 32. The system of claim 31, wherein the system further comprises a plurality
2 of tanks to correspondingly store a metal and one or more of a complexing agent,
3 a buffer, a pH adjuster and a reducing agent, and the piping system further
4 comprises a third plurality of routes to mix in-line the metal with the one or more
5 of a complexing agent, a buffer, a pH adjuster and a reducing agent to form the
6 plating solution.

1 33. The system of claim 32, wherein the plurality of tanks comprise a tank to
2 store DI water, and the third plurality of routes further mix in-line said DI water
3 with said mixture of a metal and at least a selected one of one or more of a

4 complexing agent, a buffer, a pH adjuster and a reducing agent, to form the
5 plating solution.

1 34. The system of claim 32, wherein the plurality of tanks comprise tanks to
2 correspondingly store DI water and a surfactant, and the third plurality of routes
3 further mix the DI water with the surfactant, and then mixes said mixture of DI
4 water and surfactant with said mixture of a metal and at least a selected one of
5 one or more of a complexing agent, a buffer, a pH adjuster and a reducing agent,
6 to form the plating solution.

1 35. The system of claim 31, wherein the system further comprises a heater
2 disposed upstream of the valve to heat the plating solution to an application
3 temperature.

1 36. The system of claim 31, wherein the system further comprises a controller
2 coupled to the electroanalytical subsystem and the valve, to configure the valve
3 based at least in part on result of the qualification analysis.

1 37. The system of claim 36, wherein the controller is equipped to compare the
2 result(s) of the qualification analysis to one or more qualification metrics.

1 38. The system of claim 31, wherein said electroanalytical subsystem
2 comprises one or more modules to perform one or more electroanalyses for one
3 or more reaction kinetics.

1 39. The system of claim 31, wherein said electroanalytical subsystem
2 comprises one or more modules to perform one or more electroanalyses for one
3 or more of adsorption, nucleation, deposition rates, pH balance, and particles

4 generation, and comparing the result(s) against one or more corresponding
5 qualification metrics.

1 40. The system of claim 31, wherein said electroanalytical subsystem
2 comprises one or more modules to perform one or more of
3 a Quart Crystal Microbalance (QCM) analysis,
4 an Open Circuit potential (OCP) analysis,
5 a pH analysis,
6 a particle count analysis, and
7 an UV-VIS analysis